

ARNOLD ARBORETUM  
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AUTUMN COLOR

THE eastern United States is fortunately located in one of the few regions of the world where brilliant autumn coloration of foliage prevails. There is only one small region in the southern hemisphere, and that in South America. In the northern hemisphere, there is a large region in eastern Asia, including central and northern Japan, and a small region in the southwestern part of Europe. In North America, the region characterized by brilliant autumn foliage extends from the Gulf of St. Lawrence to the southern United States and westward to the Great Plains, areas of extensive deciduous forests. Here the general climatic conditions are often just what is needed to produce that lovely phenomenon of nature—the autumn coloration of deciduous foliage.

In North America the most brilliant displays of autumn color are of course in southeastern Canada, northeastern United States and in certain other areas of high altitude. The further south one goes the less brilliant is the display of autumn color particularly in areas along the seacoast. In the higher altitudes of the south such as the Blue Ridge Mountains, the color is usually just as brilliant as in the northeastern United States.

In some years, the autumn color is much more pronounced than in others. There are always plants, the foliage of which turns yellow in the fall, but it is the brilliant reds and gorgeous scarlets which, in combination with the yellows, make autumn color of outstanding beauty. It is chiefly the reds and scarlets which are intensified by the right climatic conditions.

Leaves are green because they contain a complex material called chlorophyll. This is essential to the growth of all plants, except the

saprophytes and a few parasites, for it is through the action of chlorophyll that the plant can manufacture the food that it requires from crude chemicals in the presence of light and heat. Chlorophyll is a highly complex chemical material, being continually manufactured in the leaf and at the same time being continually broken down. Ordinarily, the rate of its breakdown about equals the rate of its manufacture. In the fall, the rate of chlorophyll manufacture is gradually reduced, although the rate of its decomposition is maintained. The exact cause for this phenomenon is problematical, but the accumulation of waste products in the leaf may be the principal cause.

### Why leaves are yellow

A certain stage is reached where there is little if any chlorophyll manufacture. Most of the chlorophyll already made eventually is destroyed. This is the reason why leaves are yellow, for the two yellow pigments usually present, carotin and xanthophyll, are continually masked by the chlorophyll. When most of the chlorophyll is destroyed, these pigments become apparent. These same coloring materials are present in large quantities in egg yolk, carrots, and in some yellow flowers.

When green plants are taken into dark places, such as a cellar, the leaves often turn yellow. Also, young shoots appearing for the first time under the dark conditions of the cellar are usually yellow. This is explained by the fact that chlorophyll is manufactured only in the presence of light. When light is absent, plants are unable to manufacture new chlorophyll and the yellow pigments become predominant as soon as all the previously manufactured chlorophyll has been destroyed.

The gradual cessation of chlorophyll manufacture and the final breakdown of all that previously made, completes the first stage in autumn coloration. This is the reason for certain plants becoming yellow. There are some plants, like most of the magnolias for instance, the leaves of which do not turn yellow, but change from green directly to brown. For some reason, the breakdown of the chlorophyll does not start soon enough or is not complete enough to result in the appearance of the yellow pigments. The yellow color does appear in the foliage of many other plants regardless of the weather conditions. There is an interesting high degree of individuality in certain species. Red maple, for instance, usually turns a good red in the fall, but certain individuals always color yellow. The same can be said of sugar maples and several other plants. This is a most interesting physiological problem worthy of further investigation.



## Why leaves are red

The gorgeous beauty of most autumn color combinations results from the brilliant reds and scarlets, together with the yellows. The sassafras, some of the maples, oaks, sumacs, sourwood, tupelo, and other plants are particularly outstanding for their brilliant red autumn color. These plants are most interesting in that the brilliance of their color apparently varies from year to year. The red in their leaves is caused by a third pigment called anthocyanin, which results in some way from the accumulation of sugars and tannins in the leaf. In some of the maples valued for their sugar production, it is probably the sugars which cause this red color. The oaks, however, being rich in tannins probably owe their high autumn coloration to the presence of these.

There are two factors necessary in the production of red autumn color. The first is light. There must be warm, bright, sunny days in the fall, during which time the leaves naturally manufacture a great deal of sugar. Secondly, such days must be followed by cool nights, during which the temperature is below 45° F. Plant physiologists have shown definitely that, under such conditions, there is little or no translocation of sugars and other materials from the leaf to other parts of the plant. In other words, when cool nights occur, following warm, bright, sunny days, sugars and other materials are "trapped" in the leaves. The accumulation of these products results in the manufacture of the red anthocyanin.

The combination of these factors is well understood when one observes a certain tree that may be red only on that side exposed to the sun. Other leaves not directly in the sun's rays may be green or yellow. Leaves exposed to the sun have been able to manufacture more sugars, which when accumulated and "trapped" in the leaves by cold night temperatures may result in the red color. It is interesting to note that trees and shrubs growing in swamps and other low places are often among the first to color in the fall, simply because it is in such places that cold air first settles on still nights.

## Dull autumn coloration

A warm, cloudy fall, sometimes with much rain, will restrict the formation of bright colored foliage. With insufficient sunlight, the sugar production is greatly reduced, and with warm nights, what little sugar has been manufactured in the leaves can be readily transported to the trunk and roots where it has no effect on the color of the foliage.

The leaves of many evergreens change color in autumn. Some of the junipers and arborvitaes are listed in the following groups. Some

pinus may turn yellow, but usually such color lasts only for a short time, the leaves quickly turning brown. This is particularly true of those evergreen leaves which are normally shed each year, and although the autumn color may not be conspicuous in many evergreen plants, nevertheless it is evident on close examination.

All leaves eventually turn brown. This is not an autumn color, but is merely the result of the death, and in some cases the decay of the plant tissue. Sometimes, the leaves turn brown while they still remain on the tree, as in the American beech and in some of the oaks. In other cases, like the sugar maple and the spicebush, the leaves drop from the plants while they are still brightly colored and turn brown afterwards.

Autumn color is then a physiological phenomenon which is very complex. There are plants the leaves of which will always turn yellow regardless of current climatic conditions, but many of the plants with red fall foliage will be striking in appearance only when warm, sunshiny days prevail, followed by nights with temperatures below 45° F. The sugar formation in the leaf, the amount of sunshine received by the plants, and the temperature of the air are three variable factors which to a large degree control autumn coloration.

The following lists include some of the ornamental woody plants which are valued for their autumn color and some which are not.

#### Shrubs and trees with good Yellow autumn color

|   |                      |                     |
|---|----------------------|---------------------|
| <i>Acer pennsylvanicum</i>                              |                      | Striped Maple       |
| <i>Acer saccharinum</i> ( <i>A. dasycarpum</i> )        |                      | Silver Maple        |
| <i>Acer saccharum</i>                                   | Yellow and red       | Sugar Maple         |
| <i>Aesculus parviflora</i>                              |                      | Bottlebrush Buckeye |
| <i>Benzoin aestivale</i>                                |                      | Spicebush           |
| <i>Betula</i> species                                   |                      | Birch               |
| <i>Carya cordiformis</i> ( <i>Hicoria cordiformis</i> ) |                      | Bitternut           |
| <i>Carya ovata</i> ( <i>Hicoria ovata</i> )             | Yellow brown         | Shagbark Hickory    |
| <i>Celastrus</i> species                                |                      | Bittersweet         |
| <i>Cercis canadensis</i>                                |                      | American Redbud     |
| <i>Cladrastis lutea</i>                                 |                      | Yellow-wood         |
| <i>Dirca palustris</i>                                  |                      | Leatherwood         |
| <i>Fagus grandifolia</i> ( <i>F. americana</i> )        | Golden brown         | American Beech      |
| <i>Fraxinus americana</i>                               | Yellow to red purple | White Ash           |
| <i>Ginkgo biloba</i>                                    |                      | Maidenhair-tree     |
| <i>Hamamelis mollis</i>                                 |                      | Chinese Witch-hazel |
| <i>Hamamelis vernalis</i>                               |                      | Vernal Witch-hazel  |
| <i>Hamamelis virginiana</i>                             |                      | Common Witch-hazel  |
| <i>Hypericum</i> species                                |                      | St. Johnswort       |

|                             |                  |                     |
|-----------------------------|------------------|---------------------|
| Liriodendron Tulipifera     |                  | Tuliptree           |
| Phellodendron amurense      |                  | Amur Corktree       |
| Populus alba                |                  | White Poplar        |
| Populus grandidentata       | Orange yellow    | Large-toothed Aspen |
| Populus nigra italica       |                  | Lombardy Poplar     |
| Populus tremuloides         |                  | Quaking Aspen       |
| Quercus imbricaria          | Yellow brown     | Shingle Oak         |
| Rosa rugosa                 | Yellow to orange | Rugosa Rose         |
| Rosa virginiana (R. lucida) |                  | Virginia Rose       |
| Ulmus americana             |                  | American Elm        |
| Zelkova serrata             |                  | Sawleaf Zelkova     |

### Shrubs and trees with good Red autumn color

|                                       |                |                       |
|---------------------------------------|----------------|-----------------------|
| Acer ginnala                          |                | Amur Maple            |
| Acer rubrum                           |                | Red Maple             |
| Amelanchier species                   |                | Serviceberry          |
| Aronia arbutifolia                    |                | Chokeberry            |
| Berberis (many species)               |                | Barberry              |
| Cornus alba                           |                | Tatarian Dogwood      |
| Cornus Amomum                         |                | Silky Dogwood         |
| Cornus florida                        |                | Flowering Dogwood     |
| Cotoneaster divaricata                |                | Spreading Cotoneaster |
| Crataegus phaenopyrum (C. cordata)    |                | Washington Thorn      |
| Evonymus alata                        |                | Winged Euonymus       |
| Evonymus atropurpureus                |                | Wahoo                 |
| Evonymus obovata                      |                | Running Euonymus      |
| Fothergilla major                     | Red and yellow | Large Fothergilla     |
| Hamamelis japonica                    |                | Japanese Witch-hazel  |
| Liquidambar styraciflua               |                | Sweetgum              |
| Nyssa sylvatica                       |                | Tupelo                |
| Oxydendrum arboreum                   |                | Sourwood              |
| Parthenocissus quinquefolia           |                | Virginia Creeper      |
| (Ampelopsis quinquefolia)             |                |                       |
| Parthenocissus tricuspidata           |                | Japanese Creeper      |
| (Ampelopsis tricuspidata)             |                |                       |
| Quercus (many species)                |                | Oak                   |
| Rhododendron Vaseyi (Azalea vaseyi)   |                | Pinkshell Azalea      |
| Rhus species                          |                | Sumac                 |
| Sassafras officinale (S. variifolium) |                | Common Sassafras      |
| Spiraea prunifolia                    |                | Bridalwreath          |
| Syringa oblata dilatata               |                |                       |
| Vaccinium species                     |                | Blueberry             |
| Viburnum dentatum                     | Glossy red     | Arrowwood             |
| Viburnum dilatatum                    | Russet Red     | Linden Viburnum       |
| Viburnum Lantana                      | Deep red       | Wayfaring-tree        |



|                             |                   |                     |
|-----------------------------|-------------------|---------------------|
| <i>Viburnum Lentago</i>     | Purple red        | Nannyberry          |
| <i>Viburnum prunifolium</i> |                   | Blackhaw            |
| <i>Viburnum tomentosum</i>  | Velvety, dull red | Doublefile Viburnum |

### Shrubs and trees with Bronze to Purple autumn color

|  |                      |                     |
|--|----------------------|---------------------|
| <i>Cornus racemosa</i>                   |                      |                     |
| ( <i>C. paniculata</i> )                 | Reddish to purple    | Gray Dogwood        |
| <i>Forsythia viridissima</i>             | Reddish purple       | Greenstem Forsythia |
| <i>Fraxinus americana</i>                | Red purple to yellow | White Ash           |
| <i>Gaultheria procumbens</i>             |                      | Wintergreen         |
| <i>Juniperus horizontalis plumosa</i>    |                      |                     |
| <i>Juniperus virginiana</i>              |                      | Red Cedar           |
| <i>Leucothoe Catesbaei</i>               |                      | Drooping Leucothoe  |
| <i>Ligustrum obtusifolium Regelianum</i> |                      |                     |
| ( <i>L. ibota Regelianum</i> )           |                      | Regel Privet        |
| <i>Mahonia repens</i>                    |                      | Creeping Hollygrape |
| <i>Pachistima Canbyi</i>                 |                      | Canby Pachistima    |
| <i>Rubus hispidus</i>                    | Reddish purple       | Swamp Dewberry      |
| <i>Symphoricarpus Chenaultii</i>         |                      |                     |
| <i>Thuja occidentalis ericoides</i>      |                      |                     |
| <i>Thuja plicata</i>                     |                      | Giant Arborvitae    |
| <i>Viburnum acerifolium</i>              |                      | Mapleleaf Viburnum  |

### Shrubs and trees with no autumn color

|   |                          |
|---|--------------------------|
| <i>Ailanthus altissima</i> ( <i>A. glandulosa</i> ) | <i>Ailanthus</i>         |
| <i>Akebia quinata</i>                               | Fiveleaf Akebia          |
| <i>Amygdalus Persica</i>                            | Peach                    |
| <i>Baccharis halimifolia</i>                        | Groundselbush            |
| <i>Clematis</i> (many species)                      | Clematis                 |
| <i>Daphne Mezereum</i>                              | February Daphne          |
| <i>Elaeagnus angustifolia</i>                       | Russian-olive            |
| <i>Evonymus Bungeanus semipersistens</i>            | Midwinter Euonymus       |
| <i>Hibiscus syriacus</i>                            | Shrub-althea             |
| <i>Ligustrum vulgare</i>                            | European Privet          |
| <i>Lonicera fragrantissima</i>                      | Winter Honeysuckle       |
| <i>Lonicera syringantha</i>                         | Lilac Honeysuckle        |
| <i>Lonicera thibetica</i>                           | Tibetan Honeysuckle      |
| <i>Lycium halimifolia</i>                           | Common Matrimony-vine    |
| <i>Magnolia stellata</i>                            | Star magnolia            |
| <i>Polygonum Auberti</i>                            | China Fleecyvine         |
| <i>Potentilla species</i>                           | Cinquefoil               |
| <i>Robinia pseudoacacia</i>                         | Common Locust            |
| <i>Salix blanda</i>                                 | Wisconsin Weeping Willow |
| <i>Salix pentandra</i>                              | Laurel Willow            |
| <i>Sophora japonica</i>                             | Japan Pagoda-tree        |
| <i>Vitex Negundo</i>                                | Negundo Chaste-tree      |

## Wisterias and Forsythias

Visitors to the Arboretum next spring who enter by way of the Forest Hills gate will notice two important changes in the plantings.

1. The trellis on which the wisterias were growing at the south end of the shrub collection has been removed entirely. This trellis, erected about thirty years ago, has failed badly and in the interests of safety alone had to be removed. The shrub collection is situated in a low spot which repeated temperature records have shown to be about the coldest spot in the Arboretum. The winter temperatures are as much as twelve degrees lower than on surrounding higher ground. Many times, the wisteria flower buds have suffered injury during severe winters, when they might have come through satisfactorily had the plants been placed on higher ground in a more sheltered position.

The entire wisteria collection has been moved to nearby higher ground next the old Bussey dormitory, where the temperature on the coldest nights is from 8 to 12 degrees higher than in the shrub collection. In this new situation the soil is good, and ample protection is given from severe winter winds by a planting of pine trees. A rustic arbor has been erected specifically for these wisterias and eventually they can be observed to much better advantage than on the old trellis.

The removal of the old trellis allows for more circulation of air through the shrub collection. Even more important, it permits one to get a good view of the rows of shrubs in the shrub collection from the Forest Hills entrance, a view which was previously entirely blocked by the trellis. At the same time, this change places the wisterias under far better growing conditions, where it is expected that they will flower more profusely than they have during the past few years.

2. For several years the large planting of *Forsythia suspensa* at the southeastern end of the lilacs has failed to bloom properly. The plants being badly overgrown, it became impossible to give them sufficient renewal pruning. The planting has become a dense mass of undergrowth with nearly 50% of dead wood. The shrubs are to be cut back to ground level in order to permit young vigorous plants to sprout from the old stumps. This is the only logical way to renew such a densely overgrown mass. Specimen plants in the collection have not been touched, but the lovely bank of drooping forsythia in mass will not be conspicuous at flowering time for several years. After this, the increased flowering of this bank planting will justify our present drastic measures.

Both these changes have been necessary for some time and are now made in the interests of growing better plants.

## Natural color photography at the Arnold Arboretum

A special gift from one of the generous supporters of the Arnold Arboretum last spring has enabled us to develop color photography here on a rather comprehensive scale. Throughout the growing season, a series of natural color photographs of the outstanding plants in the Arboretum was made as they came into flower or fruit. In the fall, a special effort was made to photograph as many plants as possible to show full autumn color. This project has taken much time and rather heavy expenditures were involved. The season's work resulted in a collection of over six hundred lantern slides in natural colors. Since the process is an expensive one, the intrinsic value of the slides themselves is rather great and hence they are not available for loans.

These slides, illustrating plants in their true colors, have a high esthetic and educational value. Realizing this the Arboretum takes pleasure in announcing that for nominal cost one of its staff members will present to interested organizations any one of the following lectures illustrated by these slides:

"The Arnold Arboretum, America's greatest garden."

"Attractive shrubs with gay berries."

"Autumn coloration."

"Flowering trees and shrubs pictured in their order of bloom."

For conditions and details address the Arnold Arboretum, Jamaica Plain, Massachusetts.

### Hedge demonstration plot

We are glad to announce the planting of a hedge demonstration plot, planned to show clipped hedges, each about 25 feet long, representing 115 plant species and varieties. This plot is on South Street in front of the Bussey Institution building near the Arboretum greenhouses. Since these hedges have just been planted, most of the deciduous species have been cut to the ground. Consequently they will not attain good hedge size for at least two years. Detailed information concerning this plot will be given in the Bulletin next spring. This note is published to record the fact that this innovation has been started and to give public recognition to the following nurseries which generously contributed the necessary plants. Without their aid, this project could not have been initiated on such a comprehensive scale.

|  |            |
|--|------------|
| Bay State Nurseries, Framingham, Massachusetts | 750 plants |
| Kelsey-Highlands Nursery, East Boxford, Mass.  | 131 plants |
| Henry Kohankie & Son, Painesville, Ohio        | 40 plants  |

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